

**UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant: Robert E. Higashi et al.  
Serial No.: 10/750,581  
Filed: December 29, 2003  
For: MICRO FUEL CELL  
Docket No.: H0005015-1100.1237101

Confirmation No.: 8573  
Examiner: Alix Echelmeyer  
Group Art Unit: 1745  
Customer No.: 90545

**SUPPLEMENTAL DECLARATION UNDER 37 C.F.R. § 1.131**

Mail Stop Amendment  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**CERTIFICATE OF ELECTRONIC TRANSMISSION**

I hereby certify that this paper is being electronically transmitted to the United States Patent and Trademark Office on the date shown below.

Lynn Thompson      3-11-10  
Lynn Thompson      Date

We, Robert E. Higashi, Khanh Q. Nguyen, Karen M. Newstrom-Peitso, Tom R. Rezachek, and Roland A. Wood, as the inventors of the claimed invention of the above-identified application, declare as follows:

This Declaration is to establish completion of the invention in the above-identified application in the United States at a date prior to April 30, 2003.

**Facts and Documentary Evidence**

All work on the invention included in the above-identified application was completed in the United States.

The invention of the above-identified patent application was completed prior to April 30, 2003. As evidence of this, attached hereto as Exhibit 2 are true and accurate copies of certain pages from a report entitled "AMPGen: Active Micro Power Generator", with dates removed. From the dates set forth on the AMPGen report (which have been redacted from the attached

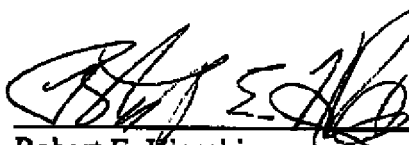
U.S. Application No. 10/750,581  
Declaration under 37 C.F.R. §1.131

copy), we can tell that the fuel cell shown in FIG. 9 was made and tested prior to April 30, 2003. The fuel cell shown in FIG. 9 was made in accordance with the invention and was tested and found suitable for its intended purpose as shown in FIG. 10. The report shows that the invention of the above-identified patent application was completed prior to April 30, 2003.


We hereby declare that all statements made herein are of my own knowledge and are true and all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Respectfully submitted,

Date: 3/9/10

  
Robert E. Higashi

Date: 3/9/10

  
Khanh Q. Nguyen

Date: \_\_\_\_\_

\_\_\_\_\_  
Karen M. Newstrom-Peitso

Date: 3/9/10

  
Tom R. Rezachek

Date: \_\_\_\_\_

\_\_\_\_\_  
Roland A. Wood

Exhibit 2

# **AMPGen: Active Micro Power Generator**

**Contract Number F33615-01-C-2171**

**Quarterly Status Report for the Period ending**

**CDRL Data Item A007**

Preparation Date:

Prepared By:

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Dr. R A Wood  
Principal Investigator

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Dr. Cleo Cabuz  
MicroDevices Laboratory Manager

**UNCLASSIFIED**

Distribution authorized to U.S. Government Agencies only. Other requests shall be referred to:

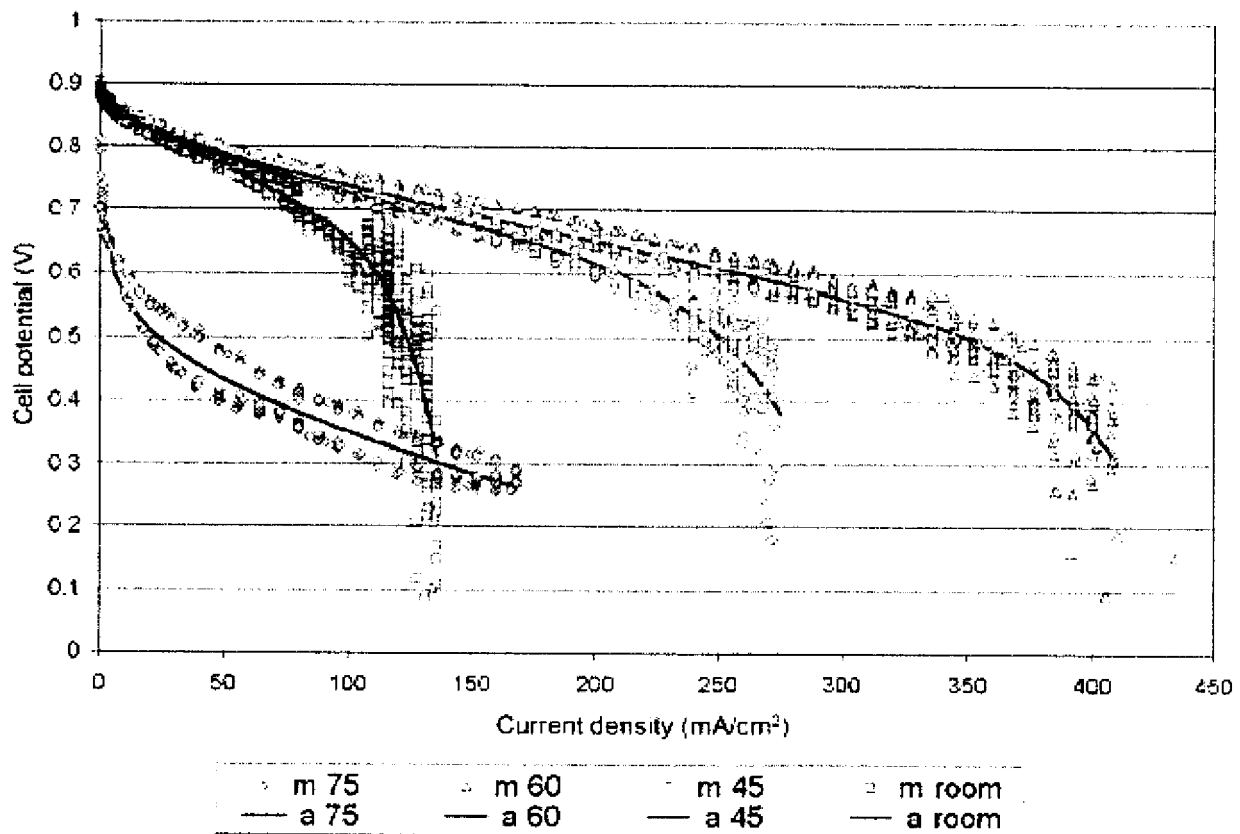
Air Force Research Laboratory

2310 8th Street

Wright Patterson AFB, OH 45433-7801

(\*) This report also constitute a semiannual report for the period ending \_\_\_\_\_

- Ambient temperature was  $28 \pm 0.5$  °C and relative humidity  $49 \pm 2$  %.
- 99.999 % pure non-humidified hydrogen was used.



**fig 8. experimental data on fuel cell operation with dry hydrogen.**

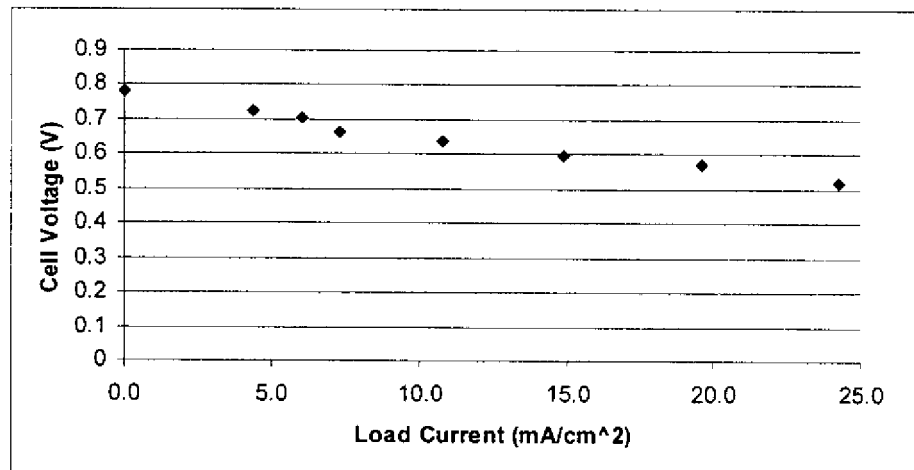
At a temperature of -10C and -25C dew point the conductance of Nafion has been measured (T Reitz communication) to be 1.8mS/cm. Thus a Nafion PEM 1 mil thick and 1mm<sup>2</sup> area would have an electrical resistance of  $1/1.8e-3 * 25e-4/0.01 = 140$  Ohms, and a current density of 10mA/cm<sup>2</sup> would produce an Ohmic voltage drop across the PEM of 14mV, a negligible voltage loss. Thus the prospects are quite encouraging that AMPGen modules will operate well below the freezing point of water.

To obtain practical experience with fuel cells operating with dry hydrogen at low temperatures, a fuel cell was constructed, shown in fig 9. The PEM was Nafion™ lot number W37385AB, 40um thickness, 2mm diameter, with carbon electrodes with 0.3mg/cm<sup>2</sup> Pt, cost 55 cents per cm<sup>2</sup>, supplied by Ion Power Inc ([www.ion-power.com](http://www.ion-power.com)). The electrodes were aluminized mylar with an adhesive surface. One side of the fuel cell

was exposed to a slowly flowing stream of dry hydrogen, and the other side was open to the laboratory room air. The fuel cell produced an open circuit voltage of about 0.75V and maintained that for a period of a few days, the duration of the test. The V-I characteristic is shown below. It can be seen that the goal current density (about 10mA/cm<sup>2</sup>) was achieved.



**fig 9** prototype fuel cell (since PEM cell 2mm diameter). Dry hydrogen flows slowly along the gas line which leads past one side of the PEM. The other side of the PEM (dark circular area) is open to laboratory air.



**fig 10.** Measured V-I characteristic of the fuel cell of fig 5. AMPGen requirement is about 0.6V at about 10mA/cm<sup>2</sup>.